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Advanced Structural Concrete - Colloquium 1

(101-0127-00L)

Topic: Stress fields **Design of a bridge diaphragm (low slenderness)**

Hand out 12. October 2023, HIL E 7

1 Dimensioning bases of the exercise

1.1 Introduction

This colloquium helps to introduce the accompanying exercise with the goal of learning how to apply stress fields and strut-and-tie models to a problem with 3D effects. In this colloquium, the diaphragm of a hollow box girder bridge over a bridge pier is to be dimensioned in accordance with the provisions of the design standard SIA 262 [1]. The box girder is supported above the pier by a single bridge bearing located at the centreline of the bridge (see Figure A1.1). The diaphragm should be designed for the ultimate limit state.

1.2 Geometry

The dimensions can be taken from overview A1.1. The diaphragm must be provided with an access opening, which provides access for material transport during the construction state and for inspections and reparations in the final state. The minimum dimensions of the opening are as follows: b x h = 0.8 m x 0.9 m.

1.3 Material

For the construction of the bridge, concrete C40/50 and reinforcing steel B500B are used.

1.4 Exposure classes

The diaphragm is located inside the hollow box in an environment with relatively constant humidity and not exposed to de-icing salts. The design concrete cover amounts to c_{nom} = 45 mm.

1.5 Loads

The support reaction R_d is 15 MN per bearing (design value). To simplify, it can be assumed that each adjacent web of the box girder carries an equal amount of shear to the support (i.e. V_{L1}= V_{L2}= V_{R1}= V_{R2}= R_d/4, see Figure A1.2). It is assumed that the diaphragm does not have to transmit torsion or horizontal forces. The dead weight of the cross member may be neglected.

2 Task

Determine the required dimensions of the diaphragm and develop a suitable strut-and-tie model for transferring the loads assuming that no prestressing is used. Assume the two following two extreme cases:

1. The entire load of the webs shall be suspended to the top of the diaphragm. The necessary suspension reinforcement shall be arranged in the area shown in Figure A2.1.
2. No suspension reinforcement shall be used.

Determine the required reinforcement in each case and carry out the necessary verifications.

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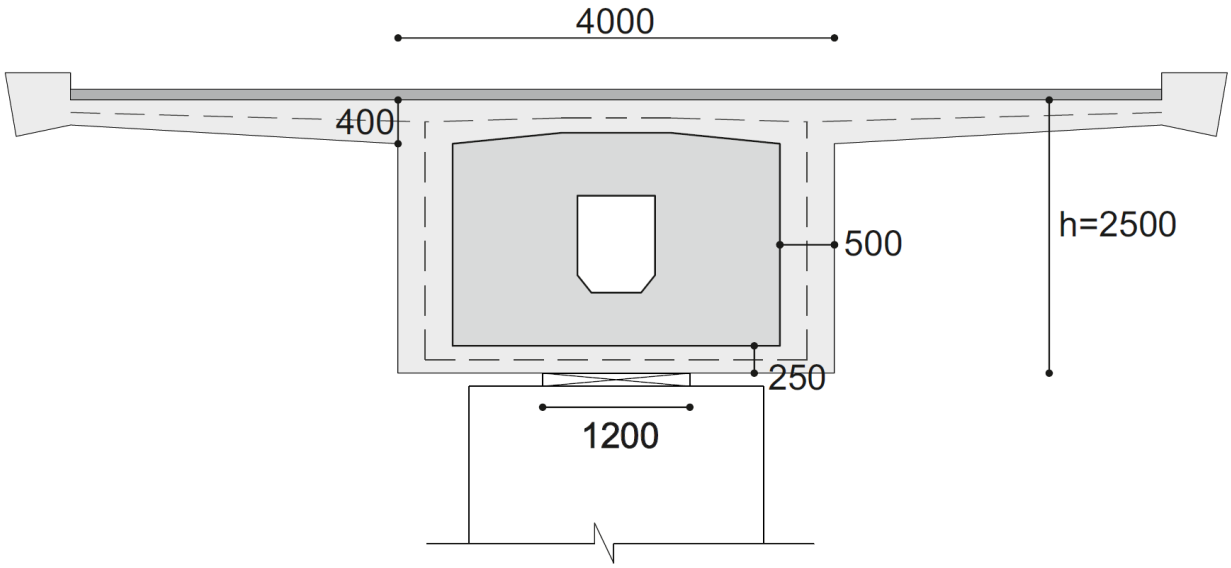
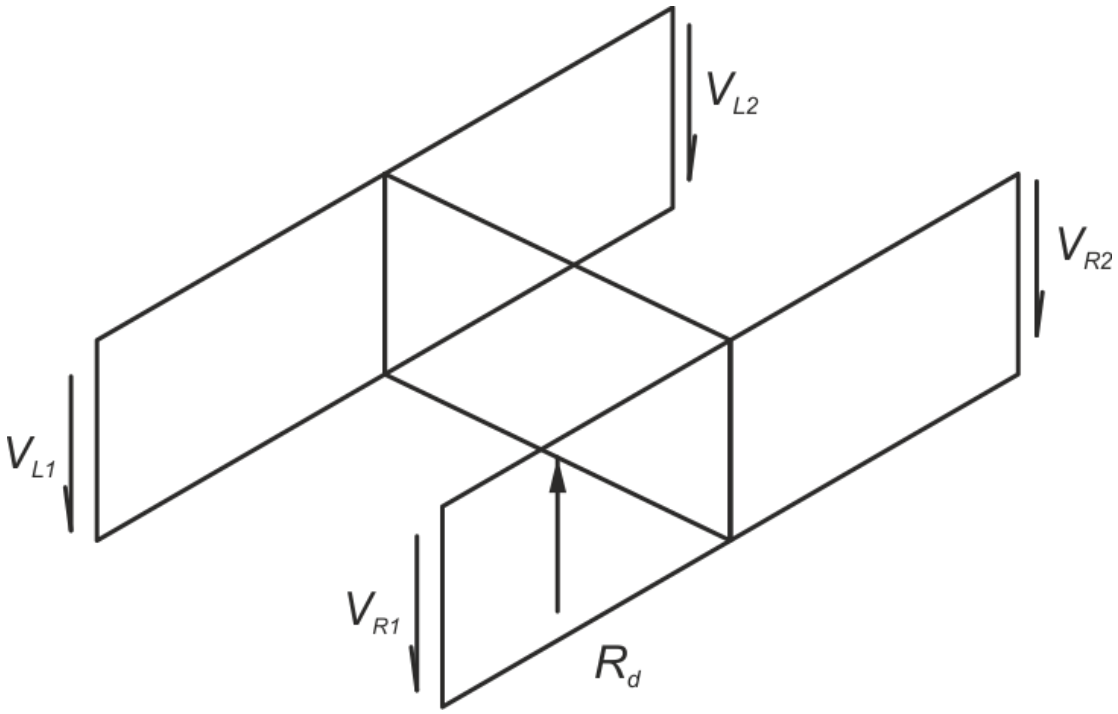
Appendix A - Figures

A1 Overview

A1.1 Cross-section of the hollow box girder (support region), diaphragm with low slenderness



A1.2 Flow of forces from the adjoining webs to the diaphragm.



A2 Area for the arrangement of the suspension reinforcement

A2.1 Section for task 1 a)